PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :
A61M 16/12

A1

(11) International Publication Number: WO 99/40961

(43) International Publication Date: 19 August 1999 (19.08.99)

(21) International Application Number: PCT/SE99/00129

(22) International Filing Date: 1 February 1999 (01.02.99)

(30) Priority Data:
9800276-9 30 January 1998 (30.01.98) SE

(71) Applicant *(for all designated States except US)*: ANMEDIC AB [SE/SE]; Galgbacksvägen 6 B, S-186 30 Vallentuna (SE).

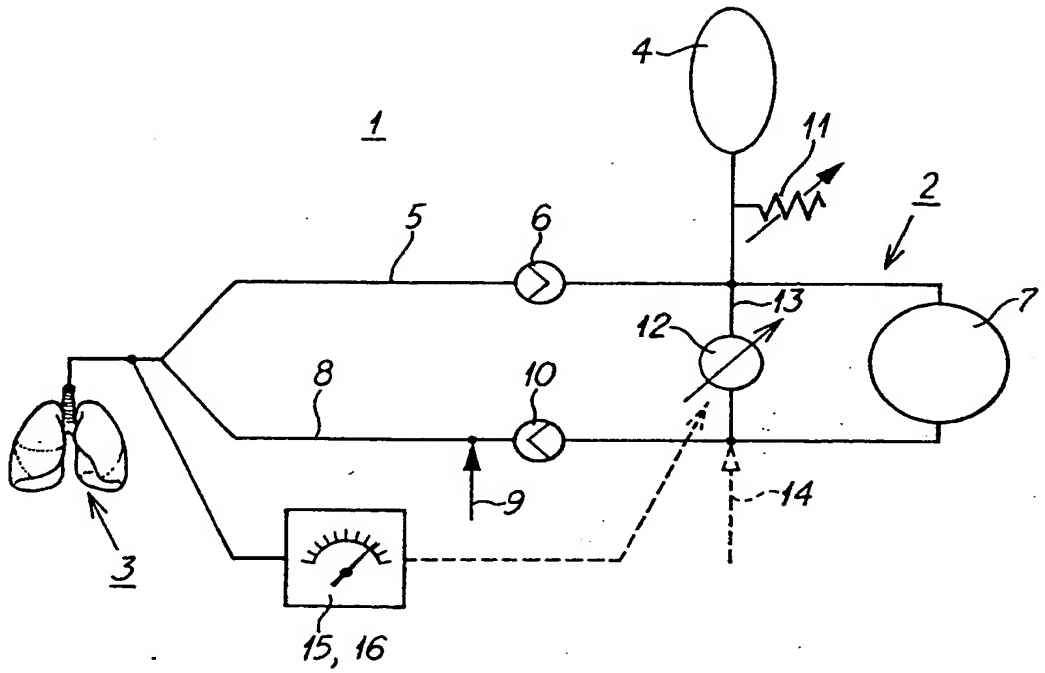
(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: KVARNHEM, Tommy [SE/SE]; Enstavägen 4, S-183 40 Täby (SE). MALIC, Danilo [SE/SE]; Tullingebergsvägen 38, S-146 00 Tullinge (SE).

(74) Agents: BERG, S., A. et al.; Albihns Patentbyrå Stockholm AB, P.O. Box 5581, S-114 85 Stockholm (SE).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: METHOD AND DEVICE FOR MIXING OF GASES



(57) Abstract

A method for mixing in breathing systems of the so-called circle type, comprising circulation of gas intended for breathing, removal of carbon dioxide from exhaled gas in a cleaning step (7) and supply of fresh gas. The method is especially characterized in that the gas intended for inhalation is supplied with carbon dioxide. The invention also regards a mixing device.

BNSDOCID: <WO___9940961A1_I_>

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

BNSDOCID: <WO___9940961A1_I_>

METHOD AND DEVICE FOR MIXING OF GASES

The present invention relates to a method for mixing in breathing systems of the so-called circle type, comprising circulation of gas intended for breathing, removal of carbon dioxide from exhaled gas in a cleaning step and supply of fresh gas.

The invention also regards a device for performing the method.

Technique of substantially this kind is previously known and associated with the advantage that the necessary addition of fresh gas, the fresh gas flow, is significantly smaller than the amount of gas which the patient is breathing per minute; the minute ventilation. In order to make this possible, the breathing gas of the patient is brought to pass an absorber unit, which absorbs the carbon dioxide of the exhalation air. The inhalation gas then will consist of "used" gas free from carbon dioxide and a minor portion of fresh gas from the breathing system. Typical values may be 1,5 litres/minute fresh gas and a minute ventilation of 10 litres/minute.

This known technique is, however, associated with disadvantages. The blood gas values of the patient is set by the composition of the inhaled gas mixture (concentration of oxygen and carbon dioxide, the number of breaths per minute and the volume of each breath, the so-called tidal volume. The number of breaths per minute (frequency) and the tidal volume is set by physiological circumstances, like e.g. the age, size and sex of the patient. It has proved difficult to obtain correct blood gas values at a correct tidal volume and frequency using known circle systems. Using e.g. 12-14 breaths/minute and a tidal volume of 8-10 ml/kg body weight, the patient will be hyperventilated, i.e. have too low a carbon dioxide content in the blood.

The hyperventilation caused by the breathing system causes several disadvantages. One of these is that the time from the end of the narcosis until the patient can breathe by himself (spontaneous breathing) will be very long, since the carbon

dioxide content of the blood must reach a certain level for spontaneous breathing to occur. This, in turn, means a low operation efficiency, since the time for each patient to pass will be long. The present invention constitutes a simple and inexpensive solution to the above described problems, which are associated with the circle system being very efficient from other points of view.

Thus, the invention relates to a method according to the introductory part of the attached claim 1. The method is especially characterized in what is specified in the characterizing part of said claim.

Further, the invention relates to a breathing system according to the introductory part of the attached claim 8. The breathing system is particularly characterized in what is specified in the characterizing part of the last mentioned claim.

Below, the invention is described in association with exemplifying embodiments and the attached drawings, in which

Fig. 1 schematically shows a circle system having an arrangement according to the invention;

Fig. 2 schematically shows a by-pass valve according to the invention connected to an absorber unit and a connection housing to a unit, the by-pass valve being built-in in said housing;

Fig. 3 shows an arrangement substantially according to Fig. 2, in which the by-pass valve is arranged to be arranged to a present connection housing as a separate unit;

Fig. 4 schematically and more in detail shows a first embodiment of a by-pass valve arrangement substantially according to Fig. 2, in which a by-pass valve comprised by a cleaning step, a shunt valve, is totally open so that no exhalation gas passes an absorber unit comprised by the cleaning step;

BNSDOCID: <WO___9940961A1_I_>

Fig. 5 shows an arrangement substantially according to Fig. 4, in which the shunt valve is totally closed so that all exhalation gas passes the absorber unit;

Fig. 6 schematically shows a manoeuver control of a shunt valve set in a totally closed position;

Fig. 7 shows the manoeuver control according to Fig. 6 in a totally open position; and

Fig. 8 schematically shows a preferred embodiment of a system according to the invention having an automatic regulation based on carbon dioxide content in the exhalation air at the end of an exhalation.

In Fig. 1, 1 designates a breathing system of the circle type, in which in- and exhalation gas is intended to be circulated in a substantially closed pipe system 2. For ventilation of a patient 3, compression means 4 are provided and arranged, when compressing, to drive the circulation of the gas in the system. 5 designates a pipe for exhalation gas running from the patient and comprising a back valve 6 between the patient and the compression means, arranged for preventing that exhaled gas is directly returned to the patient. 7 designates a cleaning step arranged to be passed by the exhalation gas, which is intended to be pressed through the cleaning step and further in a pipe 8 for inhalation gas running to the patient. In the last mentioned pipe, a connection for the addition of fresh gas and a back valve 10 arranged to control exhalation gas to the pipe 5 for exhalation gas, when the exhalation gas enters the pipe system at exhalation, are provided.

According to a preferred embodiment the cleaning step comprises an absorber unit comprising lime and being arranged to be supplied to and passed by exhalation gas and hereby absorb carbon dioxide present in the exhalation gas. Absorber units of this kind are extremely efficient and absorb all or substantially all carbon dioxide which is present in the exhalation gas.

Preferably, the system also comprises a settable excess valve, not shown, arranged to let excess gas out of the system in order to avoid undesired pressure increase in the system.

According to the invention, devices are provided for supplying carbon dioxide to the gas intended for inhalation in order to replace part of the carbon dioxide removed in the cleaning step. According to one embodiment a by-pass valve 12 is provided, via which a part of the exhaled gas can be led past the cleaning step 7 and which, according to the embodiment shown is, e.g. via a pipe 13, connected to the circle system in parallel with the cleaning step, whereby such uncleaned gas comprising carbon dioxide is intended to be supplied to the pipe 8 for inhalation gas. The valve 12 is manually and/or automatically settable so that a certain amount of exhalation air can be brought to pass past the cleaning step.

According to an alternative embodiment the gas intended for inhalation is intended to be supplied with external and not pre-circulated gas comprising carbon dioxide, e.g. via a pipe 14 connected to the pipe 8 for inhalation gas, as shown by a broken line in Fig. 1. Also combinations of external and internal carbon dioxide supply, e.g. according to the alternatives described, can be imagined.

15 designates devices for, preferably continuous, measuring at least one parameter correlated to the carbon dioxide content of the blood of the patient. The measurements are intended to be a base for regulating the amount of carbon dioxide, which is supplied to the gas intended for inhalation in order to obtain a desired carbon dioxide content in the blood of the patient. The regulation may be intended to be performed manually by means of e.g. the by-pass valve or the corresponding or a valve, not shown, for regulating the amount of gas comprising carbon dioxide, which is supplied externally. The regulation may also be intended to be performed automatically, whereby a control unit 16 is provided and arranged to be supplied

BNSDOCID: <WO___9940961A1_I_>

with measuring values from the measuring devices and to control the by-pass valve or the corresponding, so that a desired carbon dioxide content value of the blood of the patient is maintained.

According to preferred embodiments the measuring devices 15 are arranged for the measurement of the carbon dioxide content of the exhalation air at the end of an exhalation, the so-called endtidal carbon dioxide value. The necessary valves, such as the by-pass valve 12, are then e.g. servo-controlled.

Also according to preferred embodiments the by-pass valve or the corresponding and the absorber unit are put together to one unit 17. According to the embodiments shown in Figs. 2 and 3 a connection housing 18 is provided, by means of which the gas flow in the system is controlled. The housing 18 comprises a connection 19 for a bladder/bellows 4, a connection 20 for fresh gas, an excess valve 11, a connection 21 for exhaled gas, a connection 22 for gas intended to be inhaled and connections 23,24 for a lime container 25, which is marked only by broken lines in both Figures and which is arranged to be passed by the exhaled gas and arranged to be exchangeably fastened to the housing.

In the embodiment according to Fig. 2, a by-pass valve is integrated with the housing, which then includes a control 26, by means of which the by-pass flow may be controlled. In the embodiment according to Fig. 3 the by-pass valve is comprised by a separate valve unit 27, which is arranged to be applied to the housing and intended, among other things, for present housings as a complement. The valve unit 27 hereby includes the connections 23, 24 for the lime container.

In Figs. 4 and 5, two end positions of by-pass valve, the shunt valve, are shown in more detail, whereby the gas flow in the valve arrangement arranged in the connection housing is shown by means of arrows showing the flow direction of the gas. In Fig. 4 the shunt valve is totally open, whereby all the patient exhalation gas will be

BNSDOCID: <WO___9940961A1_I_>

returned to the patient. This corresponds to a max position, position 9, of the valve control 26, Fig. 7. In Fig. 5 the shunt valve is totally closed, whereby all the exhalation gas supplied will pass through the absorber unit and hereby be cleaned as far as carbon dioxide is concerned. which corresponds to a minimum position, position 9, of the valve control 26, Fig. 6. The shunt valve is also arranged to take positions between the end positions, whereby the exhalation gas supplied will be divided into two flows, where one runs through the absorber unit and is cleaned before it returns to the patient and one returns to the patient uncleaned. The setting of the shunt valve then decides to what extent the exhalation gas supplied is brought to pass the absorber unit.

In the preferred embodiment shown in Fig. 8 there are devices for continuously leading samples of the exhalation air of a patient to a measuring unit 15 for measuring the carbon dioxide content of the exhalation air from the patient, where the measuring unit comprises a connection 28, via which, normally digital, measuring signals corresponding to the carbon dioxide content of the exhalation air of the patient at the end of the exhalation. Hereby the unit may be of a known kind, where said connection normally is intended for obtaining remote supervision or the corresponding. The measuring signals is here intended to be supplied as a present value to a control unit arranged so that a desired carbon dioxide content in the exhalation air of the patient, which content corresponds to a certain carbon dioxide content in the blood of the patient, may be set as a desired value. The control unit is preferably arranged so that the present measuring unit is detected via the signals from it and/or are set on the control unit, which is necessary since the signals from different measuring units are somewhat different. Said by-pass valve 12 is in this case a motor-driven shunt valve arranged to be affected by signals from the control unit. so that control of the by-pass flow takes place for adaptation to the desired value set. i.e. when the carbon dioxide in the exhalation air is too low, the valve is set so that a larger amount of gas is shunted past the cleaning step. and when the

BNSDOCID: <WO___9940961A1_I_>

carbon dioxide content is too high, the valve is set so that a smaller amount of gas is shunted past the cleaning step.

The method as well as the function of the breathing system according to the invention should to a substantial part be obvious from what is stated above.

As also should be obvious the invention offers a simple and reliable solution to the problems stated in the introduction.

Especially, the advantages offered by an automatically controlled system substantially according to Fig. 8 should be pushed forward. The patient is correctly ventilated as far as possible and may be brought to regain the spontaneous breathing quickly and the shunt valve and present measuring values do not have to be firmly supervized since changes are obstructed by the control described.

Below the invention has been described in association with preferred embodiments. Of course, further embodiments and minor changes and complements may be imagined without leaving the main inventive idea.

The measurement of the carbon dioxide content of the blood of the patient preferably takes place by capnography or in another suitable known way.

BNSDOCID: <WO__9940961A1_I_>

CLAIMS

1. A method for mixing in breathing systems of the so-called circle type, comprising circulation of gas intended for breathing, removal of carbon dioxide from exhaled gas in a cleaning step and supply of fresh gas, **characterized** in that the gas intended for inhalation is supplied with carbon dioxide.

2. A method according to Claim 1, **characterized** in that carbon dioxide is supplied by supplying exhaled gas to the gas intended for inhalation, without having passed through the cleaning step.

3. A method according to Claim 1 or 2, **characterized** in that carbon dioxide is supplied by supplying external, not previously circulated gas containing carbon dioxide to the gas intended for inhalation.

4. A method according to claim 1, 2 or 3, **characterized** in that the amount of carbon dioxide, which is supplied to the gas intended for inhalation, is controlled and regulated based upon continuous measurements for obtaining a desired carbon dioxide content in the blood of the patient (3).

5. A method according to Claim 4, **characterized** in that said measurements regard the carbon dioxide in the exhalation gas at the end of the exhalation.

6. A method according to Claim 1, 2, 3, 4 or 5, **characterized** in that regulation of the carbon dioxide content of the blood of the patient takes place automatically by means of a driven shunt valve, which regulates the amount of gas which is brought to pass past the cleaning step, and is controlled by a control unit, which is provided with present values as well as desired values from a measuring unit.

BNSDOCID: <WO___9940961A1_I_>

7. A method according to Claim 1, 2, 3, 4, 5 or 6, **characterized** in that the cleaning step comprises absorption of carbon dioxide in lime.

8. A device for mixing in breathing systems of the so-called circle type comprising devices for circulation of gas intended for breathing, a cleaning step for the removal of carbon dioxide from exhaled gas and devices for the supply of fresh gas, **characterized** by devices (12,13,17) for supplying carbon dioxide to the gas intended for inhalation.

9. A device according to Claim 8, **characterized** by devices (12,13) for leading a part of the exhaled gas past the cleaning step and for supplying to the gas intended for inhalation the gas thus containing carbon dioxide.

10. A device according to Claim 9, **characterized** by a so-called by-pass valve (12) connected to the circle system in parallel with said cleaning step, whereby said valve is arranged so that a certain amount of the exhalation air passes past the cleaning step.

11. A device according to Claim 8, 9 or 10, **characterized** by devices (14) for supplying external not previously circulated gas containing carbon dioxide to the gas intended for inhalation.

12. A device according to Claim 8, 9, 10 or 11, **characterized** by devices (15) for continuously measuring at least one parameter correlated to the carbon dioxide content of the blood of the patient and devices (16) for regulating the amount of carbon dioxide supplied to the gas intended for inhalation. for obtaining a desired carbon dioxide content in the blood of the patient.

BNSDOCID: <WO___9940961A1_I_>

13. A device according to Claim 8, 8, 10, 11 or 12, **characterized** by devices (15) for measuring the carbon dioxide content of the exhalation gas at the end of an exhalation.

14. A device according to Claim 8, 9, 10, 11, 12 or 13, **characterized** by a driven shunt valve for automatic regulation of the amount of gas which is brought to pass past the cleaning step, which valve is arranged to be controlled by a control unit, arranged to be supplied with different desired values as well as present values from a measuring unit.

15. A device according to Claim 14, **characterized** by a control unit arranged to receive and process signals from different kinds of measuring units and, preferably, to detect the kind of measuring unit based upon the signals.

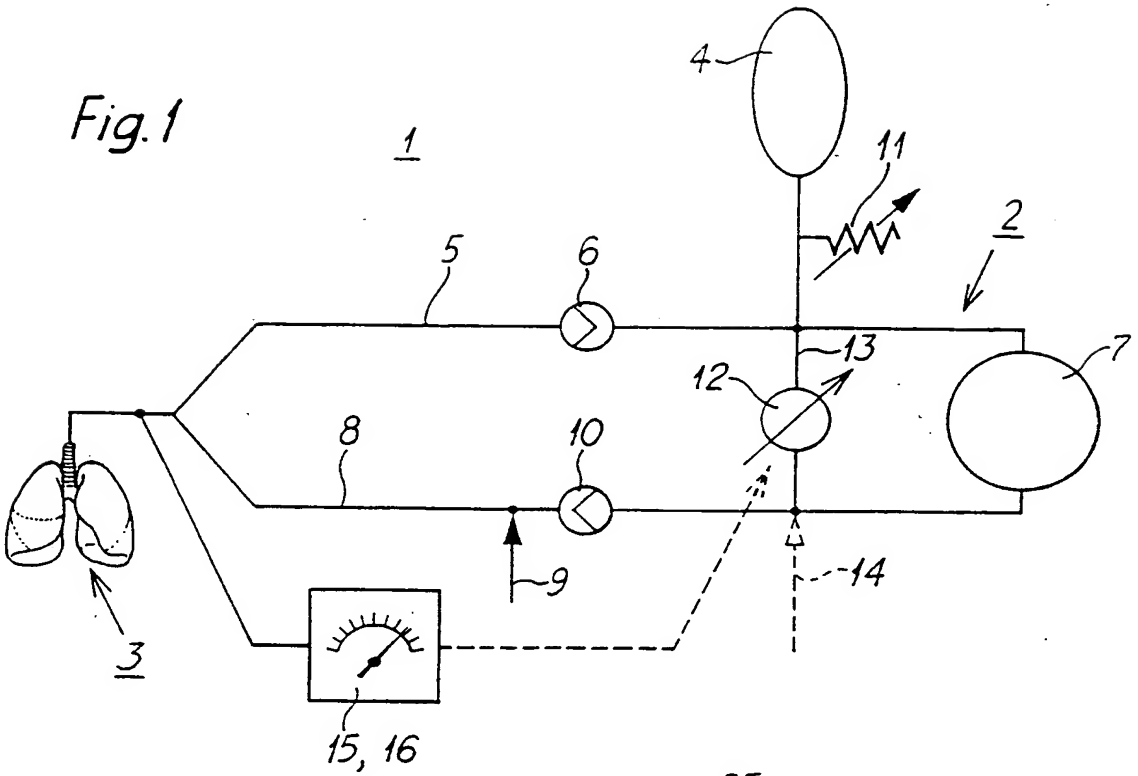
16. A device according to Claim 14 or 15, **characterized** in that the normal connection for external extraction of signals of the measuring unit is connected to the control unit.

17. A device according to Claims 8, 9, 10, 11, 12, 13, 14, 15 or 16, **characterized** by an absorber unit (7) comprising lime and arranged to be supplied with exhalation gas and to absorb carbon dioxide present in the exhalation gas.

18. A device according to Claim 17, **characterized** in that the absorber unit and a by-pass valve for leading a part of the exhalation gas past the absorber unit are put together to a unit (17).

BNSDOCID: <WO___9940961A1_I_>

Fig. 1



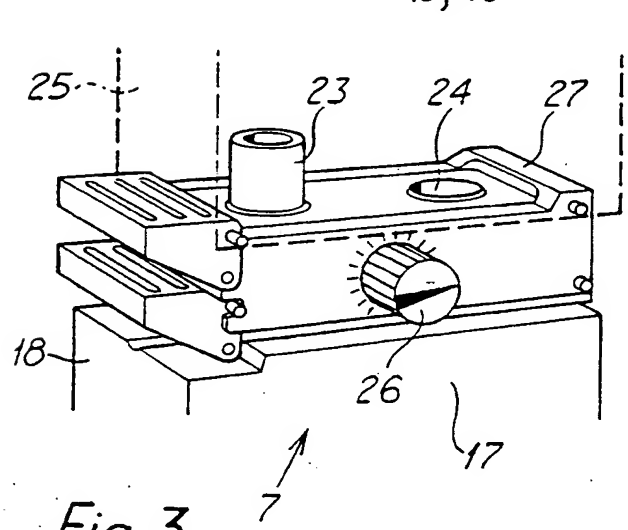


Fig. 3

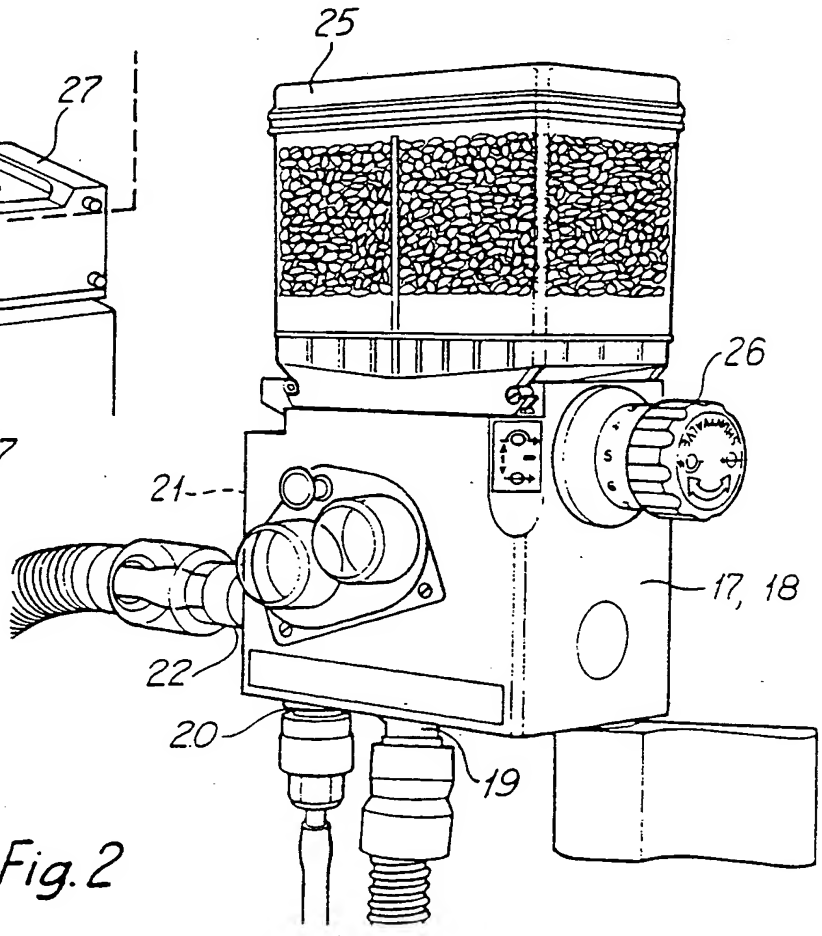


Fig. 2

BNSDOCID: <WO___9940961A1_I_>

Fig. 4

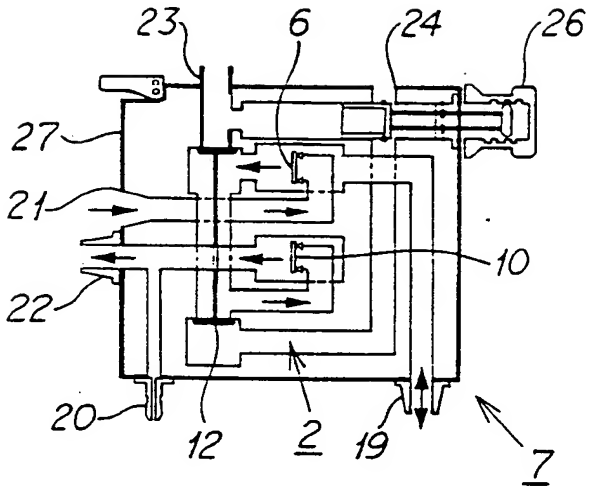
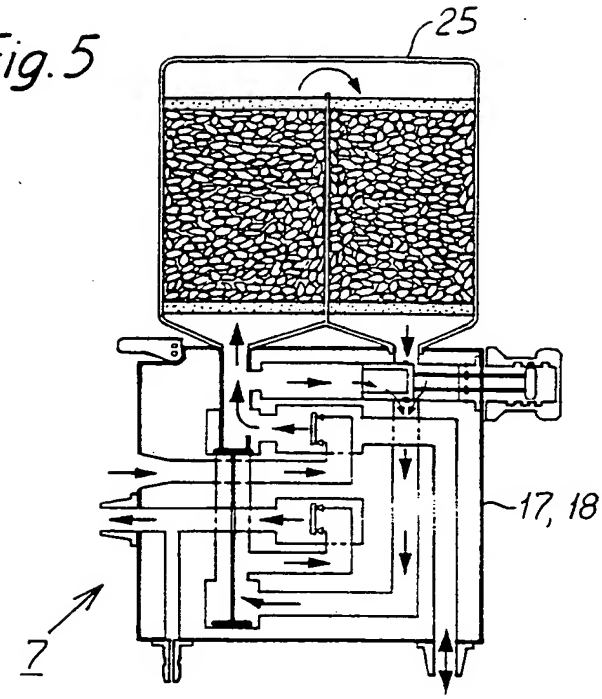


Fig. 5



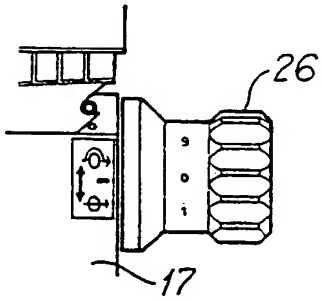


Fig. 6

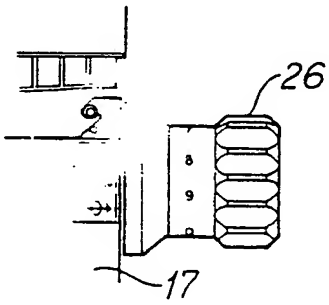


Fig. 7

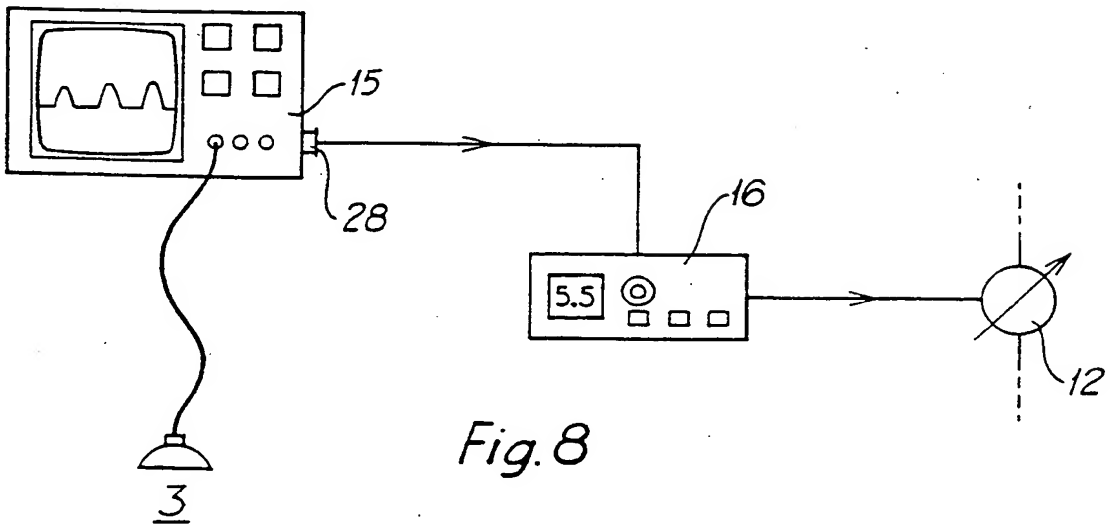


Fig. 8

BNSDOCID: <WO___9940961A1_I_>

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 99/00129

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: A61M 16/12
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9636385 A1 (JACOB & ALLARD AB ET AL.), 21 November 1996 (21.11.96), page 7, line 23 - line 38, figure 1, abstract ---	1-18
X	DE 2543266 A1 (MOYAT, PETER), 7 April 1977 (07.04.77), see the whole document --- --------	1-18

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 May 1999	31 -05- 1999
Name and mailing address of the ISA: Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Joni Sayeler Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

BNSDOCID: <WO__9940961A1_I_>

INTERNATIONAL SEARCH REPORT

Information on patent family members

07/04/99

International application No.
PCT/SE 99/00129

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9636385 A1	21/11/96	AU 5786096 A	29/11/96
		EP 0825886 A	04/03/98
		SE 506727 C	02/02/98
		SE 9501792 A	16/11/96
DE 2543266 A1	07/04/77	NONE	

BNSDOCID: <WO___9940961A1_I_>